

# 712CD

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# **Lessons Learned from COMOPTEVFOR Use of Distributed Engineering Plant (DEP) in a Recent NGC2P Operational Assessment (OA)**

Paul Symborski

Operational Test and Evaluation Force / Center for  
Naval Analyses

MORS Symposium

14 June 2007

# Take Aways



- COMOPTEVFOR leveraged a DEP test event to provide data supporting joint interoperability assessment in an OA
- Interoperability metrics cued root-cause discovery of a serious interoperability issue
- NGC2P program pursuing TTP and materiel risk mitigation efforts prior to OPEVAL
- *DEP is a useful tool supporting interoperability testing of major combat systems and their ancillary equipment in a joint environment*
- *An OT resource, especially in early phases of testing*

# Overview



- • Leveraging of DEP event
  - VV&A lessons
  - DEP-based assessment lessons

# What's a DEP?



- Distributed Engineering Plant (DEP)
- Hardware in the loop (HWIL)
- Hardware = entire major combat systems and ancillary equipment
- Multiple system labs linked by ATM-VLAN
- Sensors stimulated with common scenario
- TDL connectivity via GTE over ATM-VLAN

# OA System Under Test: NGC2P



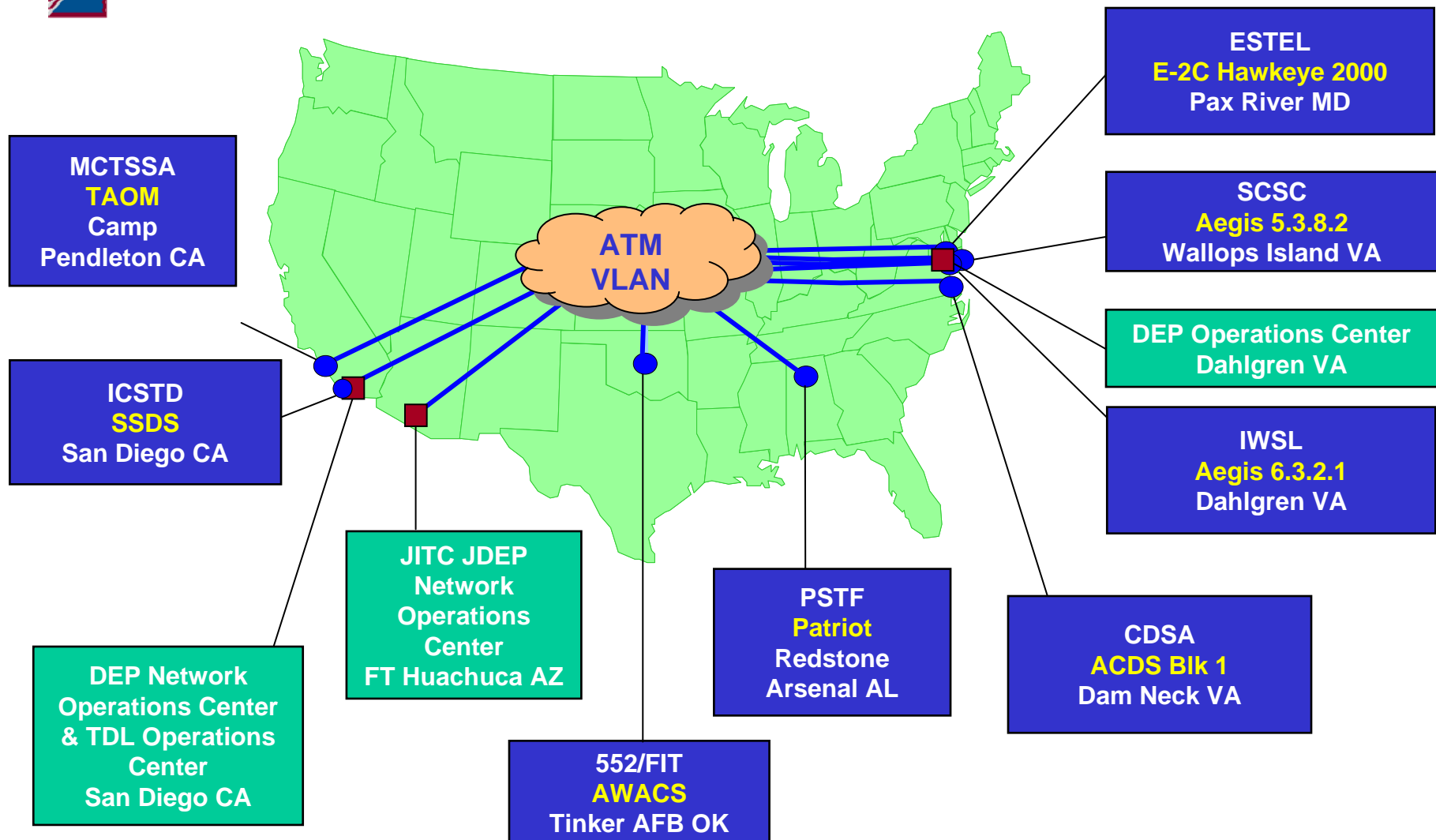
- Next Generation Command and Control Processor (NGC2P)
  - Surface Navy tactical data link (TDL) interface
  - New increment adds JRE and other capabilities
- NGC2P OA in Match 06
  - Hawaii and SOCAL
  - Two Aegis ships and land-based test site
  - Brief participation in strike group TDL
  - ***Non-Navy participants not available for test to support assessment of joint interoperability***

# C/DIT 06 Joint DEP Event

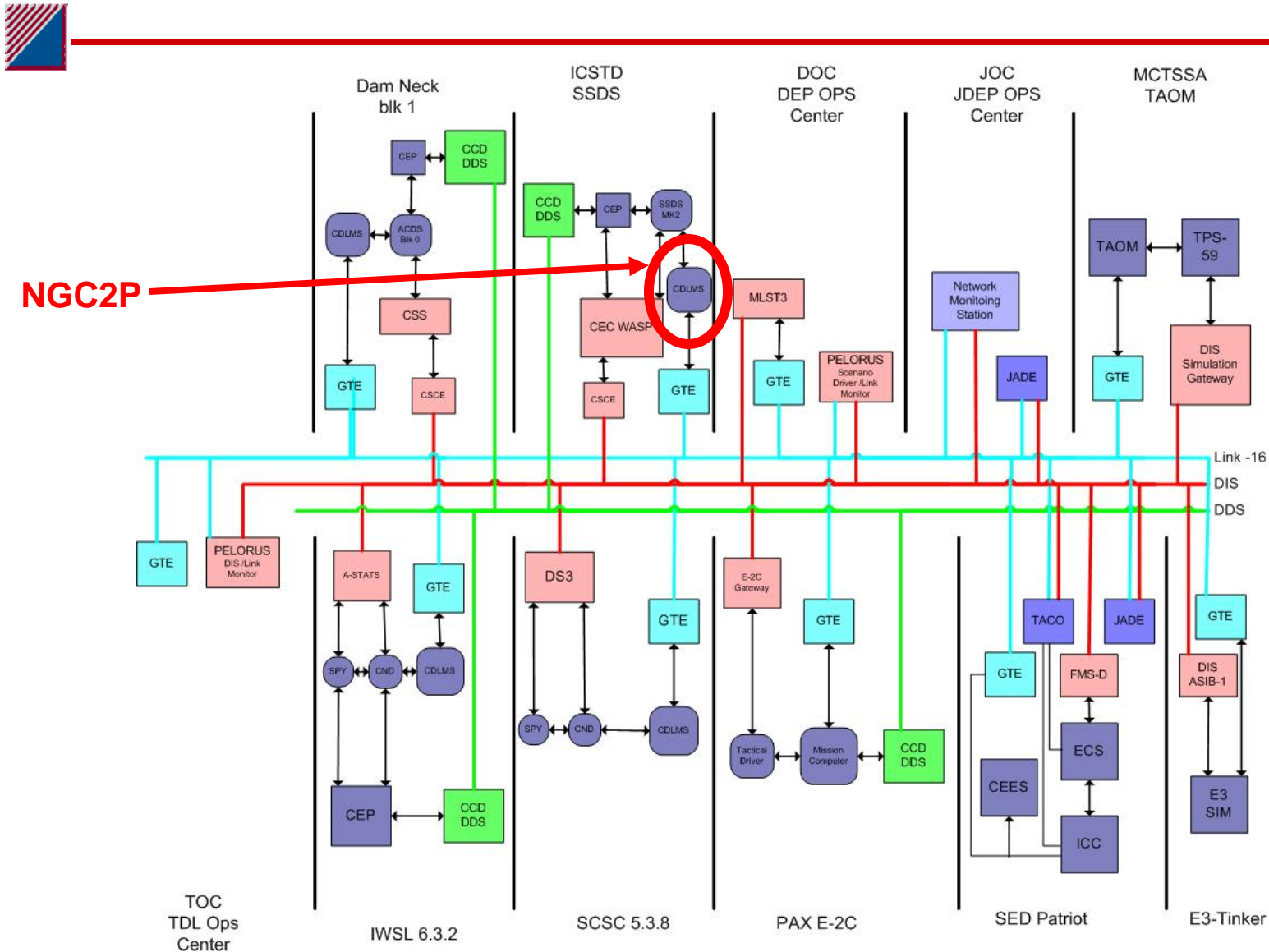


- Correlation/Decorrelation Interoperability Test (C/DIT) runs for record (first week) in DEP 27 Feb – 2 Mar 06
- Ship Self Defense System (SSDS) participant uses NGC2P as TDL interface
- Many other Navy and joint participants
  - Navy: Aegis (x2), ACDS Block 1, E-2C HE2K
  - Joint: Army Patriot and Air Force E-3 (AWACS)
- Opportunity to expand the scope of the OA to better address joint interoperability
- COMOPTEVFOR obtained permission of NGC2P program, NAVSEA, and C/DIT director to observe and analyze data in addition to live NGC2P OA events

# C/DIT 06 Participants



# C/DIT 06 DEP Event Architecture \*



# C/DIT 06 Adjunct to the NGC2P OA



- C/DIT Primary objective to test MILSTD 6016C track correlation protocol (Corr/Decorr ICP)
- But baseline cases were run “without” Corr/Decorr ICP (tactical loads)
- Robust/challenging 71-object scenario largely derived from live Red Flag and JCIET events
- Scenario and diversity of participants ideal for OA assessment of joint interoperability

# Efficiencies



- C/DIT analysis team performed air picture reconstruction supporting primary C/DIT test objectives
- C/DIT data reduction and reconstruction a fully-leveraged input to NGC2P joint interoperability assessment analysis
- OT&E cost limited to observer TAD and analyst time (~3 months) for V&V and data analysis

# Overview



- Leveraging of DEP event
- ➔ VV&A lessons
- DEP-based assessment lessons

# Verification, Validation & Accreditation (VV&A)

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- COMOPTEVFOR Policy requires M&S VV&A for HWIL
- Inadequate time to perform V&V prior to event
- Opted for concurrent V&V and analysis
- Accreditation and V&V plans developed per policy
  - M&S requirements, assessment methods, acceptance criteria:
  - Stimulation to NGC2P host combat system and other C/DIT participant's sensors
  - Emulation of TDL

# VV&A Approach



- Review relevant prior DEP V&V efforts
- Review results of C/DIT integration, risk-reduction, and dry-runs
- COMOPTEVFOR observations at ICSTD during the test
- C/DIT team observations at other sites
- Post-test analysis of combat-system track-file and data link extracts

# V&V Findings



- Six of eleven requirements completely satisfied
  - NGC2P host interface
  - Support of multiple combat systems
  - DIS interfaces
  - Scenario
  - IFF data errors
  - Airborne participants in DIS; consistent with TDL data

# V&V Findings (cntd.)



- Four requirements partially satisfied
  - Scenario objects within coverage tracked locally
    - Lack AWACS track file data to confirm true for AWACS
    - Aegis 5.3.8 participant lacked local tracks of E-2 and AWACS
  - Scenario consistency across units
    - some DIS data distortion at AWACS causing some “track jumps”
    - IFF data anomaly; later determined to be SGS/AC issue (not DEP)
  - Terminal emulator performance (latencies at Patriot site during most runs)
  - Scenario aircraft non-C2 PPLIs (update rate too slow)
- CEC/DDS requirement not satisfied (no data from runs where DDS was used)
- Note: most of the plant-related issues from C/DIT 06 week 1 have since been resolved

# Accreditation



- Plant and system problems precluded meeting many C/DIT 06 objectives
- But C/DIT 06 was adequate to support assessment of NGC2P joint interoperability for the OA with following restrictions:
  - Portions of test runs with terminal emulator latencies were not to be used
  - Runs where DDS operations were attempted were not to be used
  - Runs including non-C2 PPLIs were not to be used
  - Effects of noted anomalies on the air picture to be carefully accounted for and distinguished from NGC2P performance

# Parallel V&V and Assessment



- V&V and assessment based on identical data
- Overlap of V&V and assessment activities; efficiencies
- Analyst experience/familiarity with strengths and weaknesses of the data used for the assessment
  - Valuable in defending results and obtaining community acceptance of their credibility
  - DEP data withstood considerable post-report scrutiny due to unanticipated high-level interest in the findings
  - Validity of findings was ultimately acknowledged by all stakeholders

# Overview



- Leveraging of DEP event
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# Interoperability Assessment Methodology

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- Operational effects of interoperability performance manifest in the completeness, clarity, correctness, and commonality of information shared among FoS operators
- Information/picture quality quantified using reconstructed operational picture attribute metrics
  - Each system's tracks matched to "truth" tracks (targets instrumented)
  - Attributes scored from matched tracks
- Picture attributes correspond to requirements/KPPs in overarching MA ICDs
- Measures end-to-end operational effectiveness of information exchanges IAW OTA Commanders' stated NR-KPP assessment role (forest)
- Attribute results also cue root-cause analysis supporting fault isolation (trees)

# Air Picture (SIAP) Attributes



- Completeness: % of objects depicted
- Clarity: % of depicted objects dualized
- Continuity\*: Track number changes/hour, gaps
- Commonality\*\* : % tracks held in common  
(same position+/-, same ID, same time)
- ID Completeness: % objects identified
- ID Accuracy: % IDs correct
- ID Clarity: % IDs unambiguous

\*"Rolled up" across time by definition; non-instantaneous

\*\*Rolled up across units by definition

# Operational Picture Attributes



- Broad acceptance of SIAP attributes
  - Vetted by all services
  - Widely used in TAMD communities
- KPPs in TAMD/CID MA ICDs; required and objective performance thresholds
- Reflected in recent CDDs/TEMPs
- Adaptations to maritime and ground operational pictures

# Root-Cause Analysis



- Analysis of attributes cues root-cause analysis
  - Reveals generally degraded performance
  - Reveals performance differences between units, among reconstructed objects, vs. time
- Frequently spotlights problems not observed in real-time or during initial playback
- Cues to specific tracks/times
- Focuses analysis to relevant system data to better characterize or isolate the underling problem or problems

# OA Assessment



- Observed degraded commonality attribute
- Drilled down to specific tracks/times
- Several long-duration uncommon tracks
- Some of these isolated to SSDS host (pair-wise commonality)
- Examined relevant link message exchanges in NGC2P data
  - For affected tracks NGC2P sent different track number to host than received over TDL
  - Associated with earlier receipt of AWACS J7.4 messages

# OA Interoperability Assessment Outcome



- Operational Picture attributes cued root cause discovery of interoperability problem
  - NGC2P interpretation of AWACS J7.4 message
  - Software error in addition to the TDL standards interpretation issue
  - Track number substitution (passed different track number to SSDS host than received over TDL)
  - SSDS saw different track number than other participants on same track
  - Occasionally caused track numbers to be applied to more than one track at a time
- COMOPTEVFOR reported a joint interoperability risk
- NGC2P program risk mitigation efforts:
  - TTP/work-arounds, coordinating with NCTSI, NNWC, and USAF (Global Cyberspace Integration Center A6I)
  - Software correction
- *DEP use in OA will probably result in better outcome at OPEVAL later this year than would have occurred otherwise*

# Other OA Lessons/Considerations



- Learned more about DEP capabilities and limitations in OT context
- DEP revealed interoperability issues with high operational impact across the family-of-systems
  - NGC2P/AWACS issue
  - Also, SGS/AC software problem; fix has been developed
- *Not all bad news*; many aspects of *correct* NGC2P processing in the joint environment were demonstrated
- Serendipity was valuable, but cannot be counted upon; in general need to plan to utilize this resource whether on a dedicated or NIB basis
- Prudent to include potential use of DEP in TEMP negotiations
- Need also to ensure adequate data reduction and analysis resources/expertise on tap

# DEP is a Valuable T&E Asset



- Testing in a joint environment; it's here!
- Operational mission capability impacts of major combat system interoperability
- Expanding scope: joint and coalition (UK participation in C/DIT 07 this summer)
- Full-up combat systems include all operator interfaces; potential to explore HMI, etc.